

TECHNICAL MEMORANDUM



TO: Dennis Crumpler / OAQPS
FROM: Eric Boswell / NAREL
AUTHOR: Steve Taylor / NAREL
DATE: May 15, 2014
SUBJECT: Gravimetric Inter-Laboratory Comparison Study

Introduction

The EPA's National Analytical Radiation Environmental Laboratory (NAREL) conducts semi-annual gravimetric inter-laboratory comparison studies as part of its quality assurance support of EPA's Office of Air Quality Planning and Standards (OAQPS). The purpose of the gravimetric studies is to evaluate selected EPA and State laboratories that weigh Teflon® filters used for the determination of PM_{2.5} collected with Federal Reference Method (FRM) ambient air samplers. Results for the spring study of 2014 have been submitted by the participating test laboratories. Four EPA laboratories routinely participate in this study. EPA's Region 4 laboratory located in Athens, GA provides Pre- and Post-weighing of filters for the PM_{2.5} Performance Evaluation Program (PEP). The Region 2 laboratory located in Edison, NJ provides quality assurance oversight of laboratories in Region 2 that weigh filters for the PM_{2.5} program. The National Center for Radiation Field Operations (NCRFO) located in Las Vegas, NV provides Pre- and Post-weighing of Teflon® filters in support of the Tribal Air Monitoring Support (TAMS) PM_{2.5} air monitoring program. The Office of Air Quality Planning and Standards (OAQPS) laboratory, located in Research Triangle Park, NC performs special studies and serves as a backup weighing facility for the PM_{2.5} PEP. The Arizona Department of Environmental Quality (ADEQ) Air Filter Laboratory (AFL) and the Maryland Department of Health and Mental Hygiene (DHMH) are state laboratories that participated in this study. The state labs provide gravimetric analysis of particulate matter concentrations on filter media for their agency's air monitoring program. NAREL supplied the performance test (PT) samples and served as the reference laboratory for the study.

Mass determination of PM_{2.5} is performed using a microbalance to weigh the Teflon® collection filter before and after the sampling event. The amount of particulate matter (PM_{2.5}) captured onto the surface of the filter can be calculated by a simple subtraction of the filter tare mass or Pre-mass from the sampled filter mass or Post-mass. In order to accurately measure particulate mass at microgram levels, the microbalance must be located in a clean, dust free environmental chamber with precise temperature and humidity control. Elimination of static from samples is also very important for accurate mass measurements.

Filters used in the study were 47-mm Teflon® filters manufactured by Measurement Technology Laboratory (MTL). MTL Inc. was awarded a contract in April 2010 to supply the nation's PM_{2.5}, PM₁₀, and low-volume lead (Pb) FRM networks with 47-mm Polytetrafluoroethylene (PTFE) filters. Historically, Whatman has supplied 47-mm Teflon® filters to the networks. The MTL filters use the same filter membrane material as Whatman; however, the support ring is made from polyfluoroalkoxy (PFA) which is over twice as dense as the polymethylpentene (PMP) support ring used by Whatman. As a result, the nominal filter mass of the MTL filter is 377-410 mg compared to the Whatman nominal mass of 146-150 mg.

Three types of test samples were used in this study. The majority were 47 mm Teflon® filters that were used to sample ambient PM_{2.5}. The sampled filters are referred to as “loaded” filters in this report. In addition to the loaded filters, blank filters and metallic weights were included as controls and to provide information concerning balance stability and calibration. This study compares captured mass determined by NAREL to captured mass determined by each of the participating laboratories.

Acceptance criteria for this type of comparison have not been established. There are PEP criteria established for laboratory and field blanks, and metallic standards. According to the PEP criteria, laboratory and field blanks should not vary by more than 0.015 mg and 0.030 mg respectively between Pre- and Post-measurements. Metallic standards should not vary by more than 0.003 mg. As an alternative to the PEP criteria, this study uses criteria based on actual mass data compiled from gravimetric PT studies administered by NAREL.

Experimental

Sample sets consisting of ten new MTL Teflon® filters and two metallic weights were assembled for each of the test laboratories. Each filter was carefully inspected using a light table to check for pinholes and fibers. The metallic weights were commercially available stainless steel weights that were slightly altered by clipping a small corner section from each weight. The samples were placed into individual labeled Petri-slides and equilibrated in NAREL’s weighing chamber. Pre-mass measurements were performed before the samples were shipped by overnight mail to each test laboratory with instructions to Pre-weigh each sample following their standard operating procedures for the determination of PM_{2.5} mass. Each test lab completed its Pre-mass measurements and returned the samples to NAREL. The returned samples were then equilibrated and weighed a second time to determine NAREL’s Pre-mass of record. Results of this weighing session were compared to NAREL’s first weighing session to determine if any significant changes in mass occurred while the samples were out of NAREL’s custody. As an additional QA check, a third weighing session was also performed on a different day to verify NAREL’s Pre-mass results.

Four sampling events using three co-located Met One Super SASS air samplers were used to collect PM_{2.5} onto seven filters from each sample set. The remaining three filters from each set served as blanks. The loading schedule for the filters is shown in table 1. Table 1 shows that each lab received replicate samples of each loaded event except for the single 24 hour event.

Table 1. Sampling Schedule for Gravimetric Filters

Filter ID	Serial Number	Event	Event Duration	Receiving Lab
T14-15051	T3617114	Event 1	64 hr	Region 2
T14-15052	T3617115	Event 1	64 hr	Region 2
T14-15053	T3617116	Event 2	30 hr	Region 2
T14-15054	T3617117	Event 2	30 hr	Region 2
T14-15055	T3617118	Event 3	20 hr	Region 2
T14-15056	T3617119	Event 3	20 hr	Region 2
T14-15057	T3617120	Event 4	24 hr	Region 2
T14-15058	T3617121	----	blank	Region 2
T14-15059	T3617122	----	blank	Region 2
T14-15060	T3617123	----	blank	Region 2
T14-15061	T3695551	Event 1	64 hr	Region 4
T14-15062	T3695552	Event 1	64 hr	Region 4
T14-15063	T3695553	Event 2	30 hr	Region 4
T14-15064	T3695554	Event 2	30 hr	Region 4
T14-15065	T3695555	Event 3	20 hr	Region 4
T14-15066	T3695556	Event 3	20 hr	Region 4
T14-15067	T3695557	Event 4	24 hr	Region 4
T14-15068	T3695558	----	blank	Region 4
T14-15069	T3695559	----	blank	Region 4

Filter_ID	Serial Number	Event	Event Duration	Receiving Lab
T14-15070	T3695560	----	blank	Region 4
T14-15071	T3695561	Event 1	64 hr	NCRFO
T14-15072	T3695562	Event 1	64 hr	NCRFO
T14-15073	T3695563	Event 2	30 hr	NCRFO
T14-15074	T3695564	Event 2	30 hr	NCRFO
T14-15075	T3695565	Event 3	20 hr	NCRFO
T14-15076	T3695566	Event 3	20 hr	NCRFO
T14-15077	T3695567	Event 4	24 hr	NCRFO
T14-15078	T3695568	----	blank	NCRFO
T14-15079	T3695569	----	blank	NCRFO
T14-15080	T3695570	----	blank	NCRFO
T14-15081	T3695571	Event 1	64 hr	OAQPS
T14-15082	T3695572	Event 1	64 hr	OAQPS
T14-15083	T3695573	Event 2	30 hr	OAQPS
T14-15084	T3695574	Event 2	30 hr	OAQPS
T14-15085	T3695575	Event 3	20 hr	OAQPS
T14-15086	T3695576	Event 3	20 hr	OAQPS
T14-15087	T3695577	Event 4	24 hr	OAQPS
T14-15088	T3695578	----	blank	OAQPS
T14-15089	T3695579	----	blank	OAQPS
T14-15090	T3695580	----	blank	OAQPS
T14-15091	T3695581	Event 1	64 hr	AZDEQ
T14-15092	T3695582	Event 1	64 hr	AZDEQ
T14-15093	T3695583	Event 2	30 hr	AZDEQ
T14-15094	T3695584	Event 2	30 hr	AZDEQ
T14-15095	T3695585	Event 3	20 hr	AZDEQ
T14-15096	T3695586	Event 3	20 hr	AZDEQ
T14-15097	T3695587	Event 4	24 hr	AZDEQ
T14-15098	T3695588	----	blank	AZDEQ
T14-15099	T3695589	----	blank	AZDEQ
T14-15100	T3695590	----	blank	AZDEQ
T14-15101	T3695591	Event 1	64 hr	DHMH
T14-15102	T3695592	Event 1	64 hr	DHMH
T14-15103	T3695593	Event 2	30 hr	DHMH
T14-15104	T3695594	Event 2	30 hr	DHMH
T14-15105	T3695595	Event 3	20 hr	DHMH
T14-15106	T3695596	Event 3	20 hr	DHMH
T14-15107	T3695597	Event 4	24 hr	DHMH
T14-15108	T3695598	----	blank	DHMH
T14-15109	T3695599	----	blank	DHMH
T14-15110	T3695600	----	blank	DHMH

Following each collection event, samples were returned to NAREL's weighing chamber for equilibration. After allowing several days for filter stabilization and equilibration, the first Post-mass measurements were determined for the loaded filters as well as the blank filters and metallic weights. All mass measurements were repeated on different days to verify the initial measurements. The last weighing sessions before shipping the samples to the test labs became NAREL's Post-mass of record. The post-mass of record measurements were used to calculate NAREL's captured mass results. The filters and metallic weights were packed into small coolers with ice substitute and shipped back to the test labs for Post-weighing.

Gravimetric Results

The mass capture results reported by the test labs and NAREL are shown in figure 1.

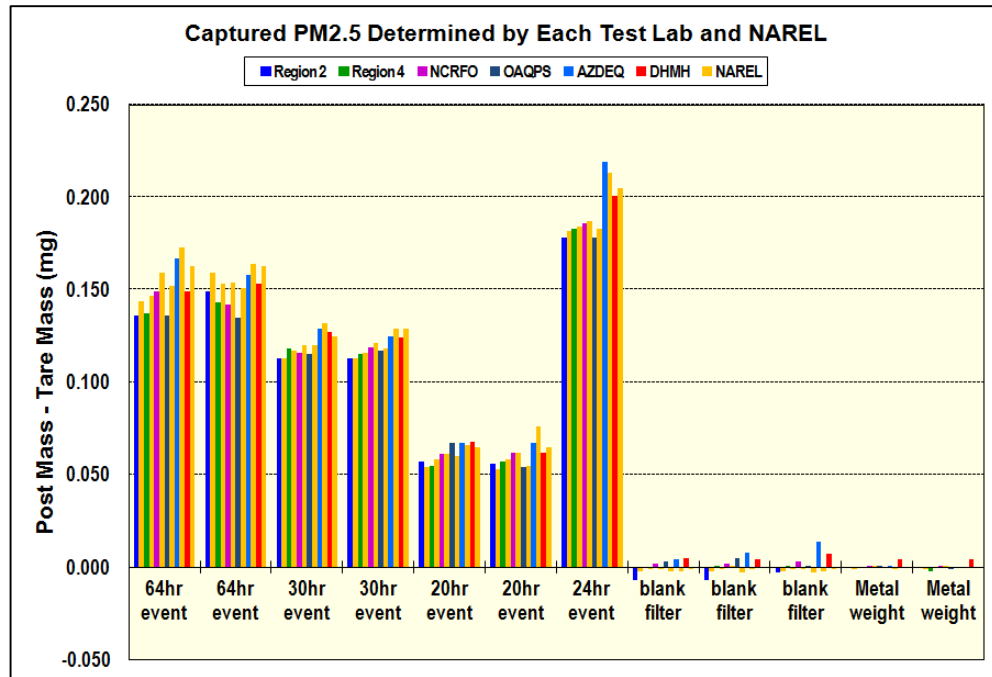


Figure 1

Each bar shown in figure 1 represents the mass capture determined by a test lab followed by NAREL's determination for the sample. Figure 1 shows that the test labs reported a smaller capture than NAREL for the majority of the loaded filters.

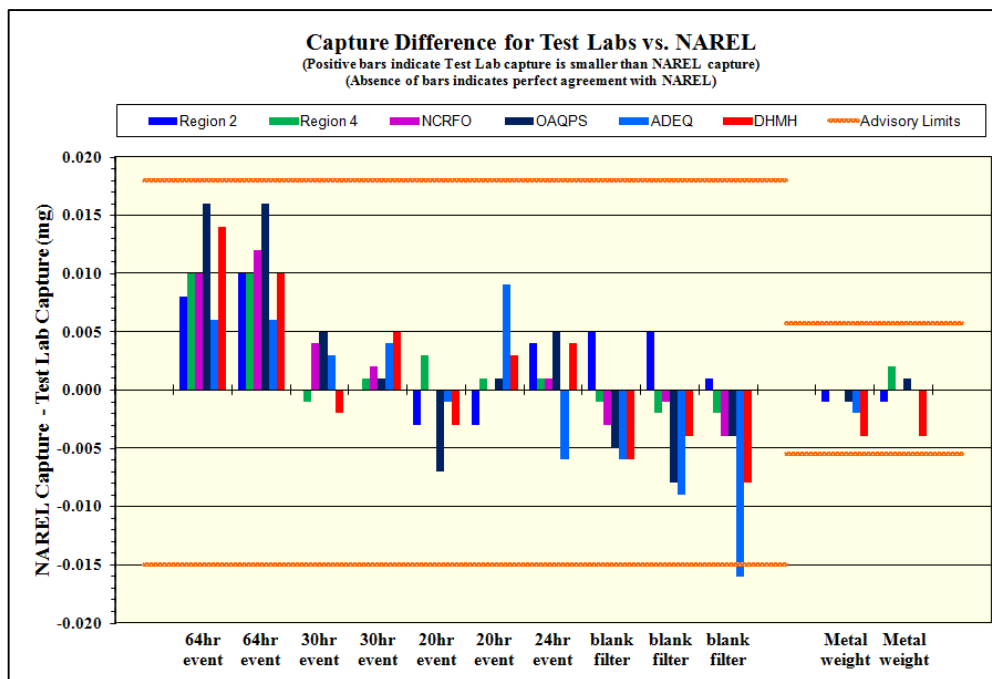
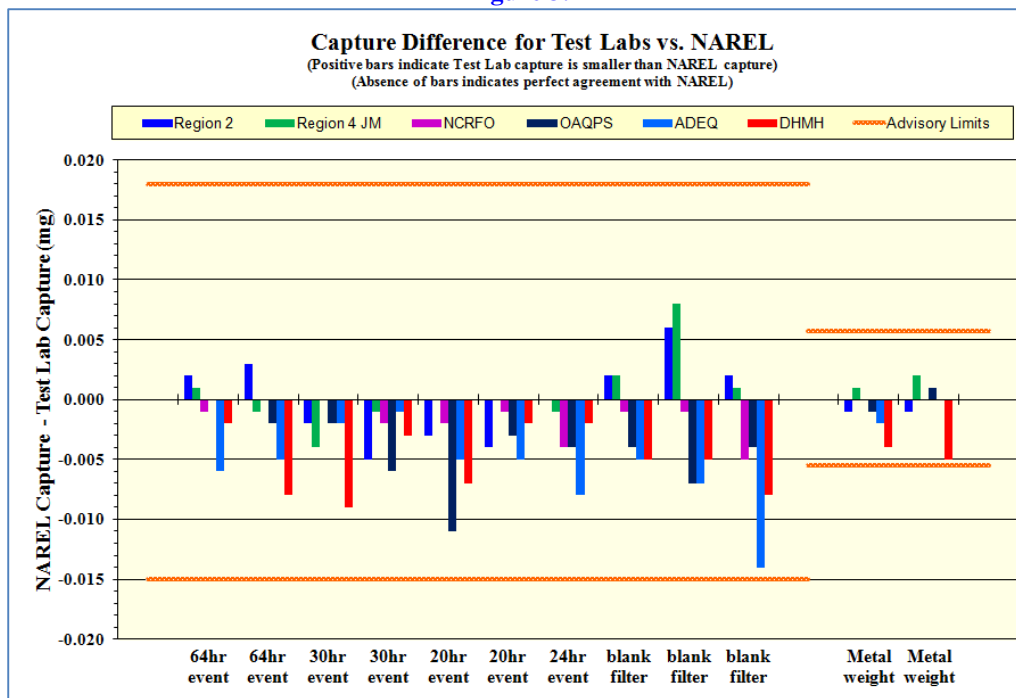


Figure 2

Figure 2 presents the inter-laboratory capture differences for all samples. Inter-laboratory differences were calculated by subtracting the capture value reported by the test laboratory from the capture value determined at NAREL. The advisory limits shown in figure 2 are 3-sigma limits derived from previous gravimetric PT studies administered by NAREL. Both figure 1 and figure 2 shows that the test labs determined smaller captured mass than NAREL for the majority of the loaded filters and larger captured mass for most of the blank filters.

Previous gravimetric studies conducted at NAREL have shown that it is not unusual for loaded filters, to lose some mass even after equilibrating in the environmental chamber for several days. The filters for this study were equilibrated from nine to twelve days before the post-mass of record and mass capture was determined. Once the test labs had completed their final measurements and returned the samples, an end of study mass determination was conducted. Depending on when the test lab returned samples, the final measurements were determined from 9 to 17 days after NAREL's post-mass of record. The average mass loss for the 20, 24, and 30 hour events was 5 μg . Average mass loss for the 64 hour event was 12 μg . Between lab capture differences using NAREL's final measurements are displayed in figure 3. The negative bars illustrate that NAREL's final calculated mass capture is smaller than the test lab's capture for the majority of samples.

Figure 3.



Metallic weights were included in this study because they are less susceptible to weighing errors due to factors such as electrical static and volatility of filter constituents. This is indicated by the much tighter advisory limits for the weights. The metallic weights were weighed at each laboratory during the initial tare sessions as well as during the final loaded sessions. The difference in initial and final mass is the calculated “mass capture” for the metallic weights. Ideally, the “mass capture” for the metallic weight samples would be zero. A large difference between an initial and final mass could indicate a balance stability or calibration problem.

The raw data used to calculate the mass capture and the inter-lab capture difference shown in figures 1 -3 are presented in table 2 at the end of this report. The table includes the results of all filters and the metallic standards weighed at each laboratory. The data includes both NAREL's post-mass of record and

the post-mass performed after the test labs had finished their measurements. Table 2 allows laboratories a convenient way to compare each of its measurements with NAREL's corresponding measurement.

Conclusions

This inter-laboratory gravimetric study evaluated laboratories that perform gravimetric measurements of PM_{2.5} collected on 47-mm Teflon® filters. The Teflon® filters used for this study were manufactured by Measurement Technology Laboratory (MTL). Samples for this study were created by loading Teflon® filters with PM_{2.5} collected from the ambient air using co-located Met One samplers. Blank filters and metallic weights were also included as samples. Each laboratory was allowed to Pre-weigh and Post-weigh a unique set of samples consisting of ten Teflon® filters and two metallic weights in order to determine the mass capture. NAREL served as the reference lab by weighing all samples. NAREL's Pre-mass of record for each sample was determined shortly after each test lab had performed its Pre-mass measurements. NAREL's Post-mass of record was determined shortly before the sample sets were shipped back to the test labs for their final Post-mass measurements. Performance was evaluated by comparing mass capture results determined by NAREL to mass capture results determined by each test laboratory. The results of this study as illustrated in figure 2 show good inter-laboratory agreement between the test laboratories and NAREL.

Once all samples were returned to NAREL, more weighing sessions were conducted to obtain an additional set of mass measurements. The purpose of the extra measurements was to demonstrate the loss of mass that can occur over time to filters with various mass loadings. As expected, filters with the largest mass capture showed the largest mass loss over time. Blank filters and metallic weights showed little or no mass change with time. Mass capture was recalculated using the additional measurements and inter-lab differences are displayed again in figure 3. Comparing figure 3 to figure 2 graphically illustrates the mass change over the time period of 9 – 17 days between measurements. Figure 3 indicates that loaded filters lost mass; however, the loss was not sufficient to cause any test lab to exceed the 3-sigma advisory limits.

Table 2. Gravimetric Mass PT Results

Sample ID	Sample Description	Tare Mass		Loaded Mass			Capture Mass			Inter-Lab Difference of		Test Lab
		Test Lab	NAREL	Test Lab	NAREL 1 st *	NAREL 2 nd **	Test Lab	NAREL 1 st *	NAREL 2 nd **	Capture 1 st *	Capture 2 nd **	
		(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	
T14-15051	64hr event	365.967	365.976	366.103	366.120	366.114	0.136	0.144	0.138	0.008	0.002	Region 2
T14-15052	64hr event	369.357	369.366	369.506	369.525	369.518	0.149	0.159	0.152	0.010	0.003	Region 2
T14-15053	30hr event	369.312	369.321	369.425	369.434	369.432	0.113	0.113	0.111	0.000	-0.002	Region 2
T14-15054	30hr event	370.296	370.310	370.409	370.423	370.418	0.113	0.113	0.108	0.000	-0.005	Region 2
T14-15055	20hr event	368.023	368.033	368.080	368.087	368.087	0.057	0.054	0.054	-0.003	-0.003	Region 2
T14-15056	20hr event	366.913	366.924	366.969	366.977	366.976	0.056	0.053	0.052	-0.003	-0.004	Region 2
T14-15057	24hr event	365.218	365.229	365.396	365.411	365.407	0.178	0.182	0.178	0.004	0.000	Region 2
T14-15058	blank filter	363.512	363.520	363.505	363.518	363.515	-0.007	-0.002	-0.005	0.005	0.002	Region 2
T14-15059	blank filter	364.576	364.585	364.569	364.583	364.584	-0.007	-0.002	-0.001	0.005	0.006	Region 2
T14-15060	blank filter	362.378	362.387	362.375	362.385	362.386	-0.003	-0.002	-0.001	0.001	0.002	Region 2
MW14-15111	Metal weight	193.818	193.823	193.818	193.822	193.822	0.000	-0.001	-0.001	-0.001	-0.001	Region 2
MW14-15112	Metal weight	93.772	93.777	93.772	93.776	93.776	0.000	-0.001	-0.001	-0.001	-0.001	Region 2
T14-15061	64hr event	361.068	361.063	361.205	361.210	361.201	0.137	0.147	0.138	0.010	0.001	Region 4
T14-15062	64hr event	359.518	359.514	359.661	359.667	359.656	0.143	0.153	0.142	0.010	-0.001	Region 4
T14-15063	30hr event	361.000	360.996	361.118	361.113	361.110	0.118	0.117	0.114	-0.001	-0.004	Region 4
T14-15064	30hr event	360.172	360.167	360.287	360.283	360.281	0.115	0.116	0.114	0.001	-0.001	Region 4
T14-15065	20hr event	359.264	359.260	359.319	359.318	359.315	0.055	0.058	0.055	0.003	0.000	Region 4
T14-15066	20hr event	357.254	357.251	357.311	357.309	357.308	0.057	0.058	0.057	0.001	0.000	Region 4
T14-15067	24hr event	356.574	356.570	356.757	356.754	356.752	0.183	0.184	0.182	0.001	-0.001	Region 4
T14-15068	blank filter	363.628	363.624	363.628	363.623	363.626	0.000	-0.001	0.002	-0.001	0.002	Region 4

Table 2. Gravimetric Mass PT Results

Sample ID	Sample Description	Tare Mass		Loaded Mass			Capture Mass			Inter-Lab Difference of		Test Lab
		Test Lab	NAREL	Test Lab	NAREL 1 st *	NAREL 2 nd **	Test Lab	NAREL 1 st *	NAREL 2 nd **	Capture 1 st *	Capture 2 nd **	
		(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	
T14-15069	blank filter	362.271	362.267	362.272	362.266	362.276	0.001	-0.001	0.009	-0.002	0.008	Region 4
T14-15070	blank filter	361.663	361.658	361.664	361.657	361.660	0.001	-0.001	0.002	-0.002	0.001	Region 4
MW14-15113	Metal weight	192.418	192.420	192.418	192.420	192.421	0.000	0.000	0.001	0.000	0.001	Region 4
MW14-15114	Metal weight	96.666	96.666	96.664	96.666	96.666	-0.002	0.000	0.000	0.002	0.002	Region 4
T14-15071	64hr event	359.144	359.14	359.293	359.299	359.288	0.149	0.159	0.148	0.010	-0.001	NCRFO
T14-15072	64hr event	365.259	365.254	365.401	365.408	365.396	0.142	0.154	0.142	0.012	0.000	NCRFO
T14-15073	30hr event	382.884	382.88	383.000	383.000	382.996	0.116	0.120	0.116	0.004	0.000	NCRFO
T14-15074	30hr event	382.993	382.987	383.112	383.108	383.104	0.119	0.121	0.117	0.002	-0.002	NCRFO
T14-15075	20hr event	360.412	360.408	360.473	360.469	360.467	0.061	0.061	0.059	0.000	-0.002	NCRFO
T14-15076	20hr event	388.415	388.409	388.477	388.471	388.470	0.062	0.062	0.061	0.000	-0.001	NCRFO
T14-15077	24hr event	384.358	384.353	384.544	384.540	384.535	0.186	0.187	0.182	0.001	-0.004	NCRFO
T14-15078	blank filter	388.659	388.656	388.661	388.655	388.657	0.002	-0.001	0.001	-0.003	-0.001	NCRFO
T14-15079	blank filter	385.977	385.972	385.979	385.973	385.973	0.002	0.001	0.001	-0.001	-0.001	NCRFO
T14-15080	blank filter	382.709	382.707	382.712	382.706	382.705	0.003	-0.001	-0.002	-0.004	-0.005	NCRFO
MW14-15115	Metal weight	186.993	186.994	186.994	186.995	186.995	0.001	0.001	0.001	0.000	0.000	NCRFO
MW14-15116	Metal weight	97.543	97.545	97.544	97.546	97.546	0.001	0.001	0.001	0.000	0.000	NCRFO
T14-15081	64hr event	387.880	387.871	388.016	388.023	388.007	0.136	0.152	0.136	0.016	0.000	OAQPS
T14-15082	64hr event	387.080	387.073	387.215	387.224	387.206	0.135	0.151	0.133	0.016	-0.002	OAQPS
T14-15083	30hr event	388.765	388.758	388.880	388.878	388.871	0.115	0.120	0.113	0.005	-0.002	OAQPS
T14-15084	30hr event	364.157	364.150	364.274	364.268	364.261	0.117	0.118	0.111	0.001	-0.006	OAQPS

Table 2. Gravimetric Mass PT Results

Sample ID	Sample Description	Tare Mass		Loaded Mass			Capture Mass			Inter-Lab Difference of		Test Lab
		Test Lab	NAREL	Test Lab	NAREL 1 st *	NAREL 2 nd **	Test Lab	NAREL 1 st *	NAREL 2 nd **	Capture 1 st *	Capture 2 nd **	
		(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	
T14-15085	20hr event	388.067	388.062	388.134	388.122	388.118	0.067	0.060	0.056	-0.007	-0.011	OAQPS
T14-15086	20hr event	377.997	377.988	378.051	378.043	378.039	0.054	0.055	0.051	0.001	-0.003	OAQPS
T14-15087	24hr event	381.672	381.666	381.850	381.849	381.84	0.178	0.183	0.174	0.005	-0.004	OAQPS
T14-15088	blank filter	377.602	377.595	377.605	377.593	377.594	0.003	-0.002	-0.001	-0.005	-0.004	OAQPS
T14-15089	blank filter	380.813	380.806	380.818	380.803	380.804	0.005	-0.003	-0.002	-0.008	-0.007	OAQPS
T14-15090	blank filter	379.137	379.131	379.138	379.128	379.128	0.001	-0.003	-0.003	-0.004	-0.004	OAQPS
MW14-15117	Metal weight	181.334	181.334	181.335	181.334	181.334	0.001	0.000	0.000	-0.001	-0.001	OAQPS
MW14-15118	Metal weight	99.356	99.356	99.355	99.356	99.356	-0.001	0.000	0.000	0.001	0.001	OAQPS
T14-15091	64hr event	378.020	378.024	378.187	378.197	378.185	0.167	0.173	0.161	0.006	-0.006	AZDEQ
T14-15092	64hr event	376.713	376.716	376.871	376.880	376.869	0.158	0.164	0.153	0.006	-0.005	AZDEQ
T14-15093	30hr event	379.742	379.745	379.871	379.877	379.872	0.129	0.132	0.127	0.003	-0.002	AZDEQ
T14-15094	30hr event	379.398	379.400	379.523	379.529	379.524	0.125	0.129	0.124	0.004	-0.001	AZDEQ
T14-15095	20hr event	373.058	373.063	373.125	373.129	373.125	0.067	0.066	0.062	-0.001	-0.005	AZDEQ
T14-15096	20hr event	361.236	361.241	361.303	361.317	361.303	0.067	0.076	0.062	0.009	-0.005	AZDEQ
T14-15097	24hr event	360.871	360.877	361.090	361.090	361.088	0.219	0.213	0.211	-0.006	-0.008	AZDEQ
T14-15098	blank filter	355.685	355.694	355.689	355.692	355.693	0.004	-0.002	-0.001	-0.006	-0.005	AZDEQ
T14-15099	blank filter	356.781	356.791	356.789	356.790	356.792	0.008	-0.001	0.001	-0.009	-0.007	AZDEQ
T14-15100	blank filter	385.126	385.138	385.140	385.136	385.138	0.014	-0.002	0.000	-0.016	-0.014	AZDEQ
MW14-15119	Metal weight	188.879	188.881	188.880	188.880	188.880	0.001	-0.001	-0.001	-0.002	-0.002	AZDEQ
MW14-15120	Metal weight	67.966	67.968	67.966	67.968	67.968	0.000	0.000	0.000	0.000	0.000	AZDEQ

Table 2. Gravimetric Mass PT Results

Sample ID	Sample Description	Tare Mass		Loaded Mass			Capture Mass			Inter-Lab Difference of		Test Lab
		Test Lab	NAREL	Test Lab	NAREL 1 st *	NAREL 2 nd **	Test Lab	NAREL 1 st *	NAREL 2 nd **	Capture 1 st *	Capture 2 nd **	
		(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	
T14-15101	64hr event	360.611	360.619	360.760	360.782	360.766	0.149	0.163	0.147	0.014	-0.002	DHMH
T14-15102	64hr event	382.212	382.224	382.365	382.387	382.369	0.153	0.163	0.145	0.010	-0.008	DHMH
T14-15103	30hr event	381.319	381.331	381.446	381.456	381.449	0.127	0.125	0.118	-0.002	-0.009	DHMH
T14-15104	30hr event	357.184	357.192	357.308	357.321	357.313	0.124	0.129	0.121	0.005	-0.003	DHMH
T14-15105	20hr event	361.948	361.956	362.016	362.021	362.017	0.068	0.065	0.061	-0.003	-0.007	DHMH
T14-15106	20hr event	358.039	358.047	358.101	358.112	358.107	0.062	0.065	0.060	0.003	-0.002	DHMH
T14-15107	24hr event	360.444	360.455	360.645	360.660	360.654	0.201	0.205	0.199	0.004	-0.002	DHMH
T14-15108	blank filter	359.523	359.536	359.528	359.535	359.536	0.005	-0.001	0.000	-0.006	-0.005	DHMH
T14-15109	blank filter	357.352	357.367	357.356	357.367	357.366	0.004	0.000	-0.001	-0.004	-0.005	DHMH
T14-15110	blank filter	357.573	357.586	357.580	357.585	357.585	0.007	-0.001	-0.001	-0.008	-0.008	DHMH
MW14-15121	Metal weight	180.861	180.868	180.865	180.868	180.868	0.004	0.000	0.000	-0.004	-0.004	DHMH
MW14-15122	Metal weight	82.346	82.353	82.350	82.353	82.352	0.004	0.000	-0.001	-0.004	-0.005	DHMH

- *NAREL post-mass determined prior to test labs post-mass measurements.
- **NAREL post-mass determined after test labs post-mass measurements.